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FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
WATERSHED MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
RANGE MANAGEMENT
FOREST SURVEY

FEB 1936

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FOREST RESEARCH

MONTHLY REPORT

February, 1936.

ALLEGHENY FOREST EXPERIMENT STATION

General

The committee of the Allegheny Forest Research Advisory Council on the coordination of research met at Harrisburg immediately prior to the winter meeting of the Allegheny Section of the Society of American Foresters. Twenty-three members, representing practically all of the organizations interested in forest research work or in the management of large forest areas in the region attended the two sessions. The tentative ten-year program of research for the territory was discussed in detail.

RESEARCH IN FOREST PATHOLOGY

Mycorrhizae (B.P.I. Project 6-P) (Dr. K. D. Doak)

Host Index. A host index of all reports in the literature regarding mycorrhizal plants was revised and finished up to the end of January 1936. This index has served as an invaluable reference in connection with the project. This revision and cross indexing with the authors' index and the abstracts filed was completed with the assistance of National Youth Administration student aid.

Herbarium. Reorganization of the herbarium system with addition of the past two year's collections was completed with the assistance of N. Y. A. student aid. This herbarium contains dried and otherwise preserved specimens of all species of fungi cultured since the project was started in 1930 and many of the closely related species found confusing in the work of identification. An exchange system with specialists in several groups of the fungi in the United States has been in operation during the past two years and has been found useful in checking the identifications made earlier.

Root Analysis. A group of seedlings taken from the various treatment beds at the Junction Nursery, Harrisburg, Illinois was analyzed for the mycorrhizal and pseudomycorrhizal characters of the root system. Pinus rigida and P. echinata were the species studied. The results of this study will give general information on the reaction of root systems under different conditions in a new nursery site outside the natural range of these two species.

New mycorrhizal host additions. Seven new combinations of fungi and coniferous hosts were determined positive, following histological study of roots removed from pure culture during the month. These had been growing in culture since July 1935 and with one exception involved fungi cultured during the season 1934.

APPALACHIAN FOREST EXPERIMENT STATION

General

In the latter part of February, about 15 of the supervisory personnel of the Pisgah-Unaka National Forest spent a day at the Bent Creek Experimental Forest inspecting the development of the forest and the different research projects under way. Particular attention was given to fire investigations, stream gauging installations, road bank control, and the work of the cooperating pathologist and entomologist. A similar meeting was held on the Toccoa Experimental Forest with the staff of the Cherokee National Forest. The treatment given each set of sample plots was discussed on the ground with particular reference to applicability on individual ranger districts.

Management (Mts.)

A question of interest in all partial cuttings is the amount of loss to be expected in the residual stand as a result of logging. In an advanced second growth stand of saw timber in cove hardwoods near Parsons, W. Va. 3 percent of the trees originally marked to remain were knocked over or so badly damaged as to be considered a complete loss for future increment. In virgin stands near Bastian, Va. losses to residual trees varied from 5 to 15 percent. The latter figure indicates excess damage where extremely difficult logging conditions required the sacrifice of some residual trees for logging construction.

Computations of a series of 46 volume tables for Appalachian mountain species were completed (Technical Note No. 19). Fifteen commercially important species were represented by the tables and where sufficient data for a species were available separate tables by site classes were made. The tables were prepared both by d.b.h. and log lengths and also by d.b.h. and average merchantable height. In the latter case both gross and net volumes were given.

Fire Studies

Following tests of the Byram haze-meter proving its applicability in this region, readings of visibility distance were made by a lookout on the Pisgah National Forest four times a day in each of the four cardinal directions for the period of 30 days during the fall fire season. Average visibility distances for this point were found to be: 9 A.M., 6.5 miles; 12 Noon, 7.0 miles; 3 P.M., 6.6 miles; and 5 P.M., 5.8 miles. At 3 P.M. the visibility distance was less than 7 miles on 70% of the days.

The McFalls Creek plots on the Mountain Lake Unit were re-examined in October, 1935. These plots were originally established in 1929, following completion of logging on the area, as methods of cutting plots in the white pine-hardwood type, Site II. The following April, the area was burned accidentally. Consequently, no unburned check plot is available. The large amount of white pine reproduction present in 1929 was practically eliminated by the fire. However, there is now a good stand of hardwoods on this area. Plot 2, the original check plot, has 2260 free single stems of desirable species per acre. This includes both seedlings and single seedling sprouts. There are free single stems of desirable species on 81 percent of the mathematically spaced milacre quadrats.

Prolonged mortality was found among the trees in the residual stand. Before the fire there were 50 trees 8 inches d.b.h. and larger, both hardwoods and conifers on Plot 2 (1 acre). Four months after the fire 24 per cent were recorded as being dead. By 1935 an additional 42 per cent had died, leaving only 17 of the original 50 trees alive. Of 12 white pines 12 inches d.b.h. and larger, present at the time of the fire, one remained alive in 1935.

Streamflow and Erosion

Road bank control treatments which have successfully held the banks during the severe repeated freezing and thawing of the past winter are honeysuckle, with root clumps set in deep pockets or furrows; orchard grass and red top seeded 20 lbs. to the acre and fertilized with a 4-8-4 complete fertilizer, 400 lbs. per acre; and leaf litter raked over 1-1 slopes and held down with brush.

Water table fluctuation in ground wells established across valley bottoms in the Coweeta Experimental Forest show for a 6 months period, variations of from 3 to 6 feet. Rises in the height of water tables are related to storm periods, and appear to follow rises in the height of the streams. The records to date indicate that the sub-surface movement of ground water in the mountain valleys of the Southern Appalachians may be a significant factor in watershed yield data.

Water level recorders have now been installed on a number of wells for continuous record of the water table fluctuation.

Fourteen months records have now been completed on the meteorological stations within the three major vegetation zones of the Copper Basin. The records for the full fourteen months' period are in line with the six months records previously reported, significant differences in wind velocities, evaporation, and temperature being found.

COPPER BASIN OF TENNESSEE

Records for fourteen Months Period

December 1, 1934 - January 31, 1936.

	FORESTED ZONE	GRASSED ZONE	DENUDED ZONE
PRECIPITATION	Total Inches	Accumulated	Precipitation
Dec. 1934-April, 1935	24.53	21.53	20.34
May - October, 1935	16.60	13.77	10.21
Nov. - January, 1936	21.24	20.50	18.84
Total	62.37	55.80	49.39
WIND	Average Miles	Per hour by	Weekly Periods
Dec. 1934-April 1935	0.9	5.1	7.0
May - October, 1935	0.2	3.9	5.1
Nov. - January, 1936	0.9	4.7	5.4
MAXIMUM AIR TEMPERATURE	Daily Average	By Weekly Deg.Fahrenheit	Periods
Dec.1934-April, 1935	55.3	55.8	54.9
May - October, 1935	77.8	81.5	81.3
Nov. - January, 1936	47.7	47.2	45.6
MINIMUM AIR TEMPERATURE	Daily Average	By Weekly Deg.Fahrenheit	Periods
Dec.1934-April, 1935	34.0	38.1	37.7
May - October, 1935	53.9	56.8	58.2
Nov. - January, 1936	28.0	31.2	31.1
SOIL TEMPERATURE AT 0" DEPTH	Daily Average	By Weekly Deg.Fahrenheit	Periods
Dec.1934-April, 1935	46.8	47.1	45.3
May - October, 1935	66.2	74.2	73.3
Nov. - January, 1936	40.7	41.1	40.9
SOIL TEMPERATURE AT 6" DEPTH	Daily Average	By Weekly Deg.Fahrenheit	Periods
Dec.1934-April, 1935	47.4	47.3	46.1
May - October, 1935	63.4	69.8	71.5
Nov. - January, 1936	43.6	43.3	42.7
EVAPORATION FROM FREE WATER SURFACE	Total Inches	Accumulated	Evaporation
Dec.1934-April, 1935	2.700	5.840	6.600
May - October, 1935	6.466	26.573	40.378
Nov. - January, 1936	2.248	4.138	5.189
Total	11.414	36.551	52.067

Fire Weather

Fire weather forecasts were discontinued December 10 and resumed March 3. Although moisture this winter was above average dry periods of sufficient length and hazard occurred to permit a considerable number of fires in eastern North Carolina in January. It is believed that hazardous periods between fire seasons, even in the mountain sections, should be given more attention.

Conditions were favorable for the early burning of brush and mention was made of this fact in the notice of February 10 to Observers and all recipients of fire weather warnings. Another notice of February 28 carried the reminder that although moisture had been plentiful serious fire hazard could develop in a surprisingly short time after the occurrence of such natural safeguards as snow or rain, and that a dry wind "fanning the fuels" was potentially more dangerous than a comparatively wet wind "fanning the flames". The clue to such rapid drying being, of course, the occurrence of relative humidity readings of 30 per cent or lower, indicating danger almost without regard for other factors.

Radio broadcasts of fire weather forecasts are made as follows: WSM, Nashville, Tenn., 12:45 p.m., C.S.T.; WOPI, Bristol, Tenn.-Va., 11:30 a.m., C.S.T.; WBT, Charlotte, N. C., 12:30 p.m., E.S.T.; and WWNC, Asheville, N. C., 12:00 Noon and 6:35 p.m., E.S.T.

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

Forest Management - Pine

The data from the 100 percent inventory of the Blacks Mountain Experimental Forest furnish an excellent basis for comparison of line-plot and strip sampling, and for finding the effect of size of area, and size and shape of plots on size of sample needed to estimate board foot volume to a given accuracy. The analyses have been completed and Hasel is now engaged in writing up the results for publication. The results will be of value in planning cruises or forest surveys.

At the start of the inventory of this area in 1933, the old problem of what percent cruise to make caused considerable concern. For the intensity of management planned, accurate stand and stock tables were needed by compartments of 100-acre average size. The decision to inventory 100 percent has been justified by the above analyses. For estimating total board foot volume with a standard error of ± 3 percent, an 82 percent cruise is indicated. For a standard error of ± 5 percent, the cruise percent drops to 63. In order to allocate volume correctly to species and tree classes, the 100 percent inventory is undoubtedly needed.

The Reineke dendrometer, used to determine radial growth, sometimes produces erratic data. In a recent test, hooks of two different sizes were used, one set being 1-3/8 inches long and the other set being 2-1/4 inches long. At the apparent end of the growing season, increment cores were taken under the round-headed bark screws.

The width of the last growth ring of each core was measured with a binocular micrometer and the total growth as measured by the corresponding dendrometer was computed for the season. The measurements were segregated by hook length. The correlation coefficient, and their errors, between the dendrometer measurements and the core measurements are tabulated below:

Class	Correlation coefficients	Number of items
2-1/4" hooks	+ 0.936 ± .014	32
1-3/8" hooks	+ 0.261 ± .079	59

Apparently the 1-3/8" hooks were not long enough to be firmly fastened in the older wood and thus caused erratic measurements. The high correlation coefficient obtained with the long hooks indicates that reliable measurements of growth are possible with the instrument.

Forest Management - Redwood

The routine analysis of the redwood logging study data was interrupted. A preliminary comparison of the three principal methods of logging used in the redwood region at the present time, slackline, high lead, and tractor yarding, are shown in the following table which is based on 1711 trips on 4 settings:

Redwood Logging - Cost per M.[1/]

Log volume feet B.M.	1000 ft. External Distance				2000 ft. External Distance		
	Slacker	High lead	Tractor A[2/]	Tractor B[3/]	Slacker	Tractor A[2/]	Tractor B[3/]
500	2.51	2.69	.82	1.75	2.43	1.39	2.10
1000	1.74	1.61	.72	1.30	1.66	1.04	1.52
3000	1.19	.91	.59	.85	1.08	.87	1.00
6000	.98	.67	.56	1.10	.85	.83	1.32

1/ Delays due to organization omitted (wait for peelers, etc.)

2/ Tractor A - 75 Diesel tractor with Carco Arch - Direct yarding

3/ Tractor B - 80 Diesel tractor with Carco Arch - Logs bunched with tractor and double drum.

The possibilities of considerable saving in logging costs by use of tractors are clearly shown. The costs for the slacker are higher at 1000 feet than at 2000 feet external yarding distance because the cost of rigging up the pole, moving donkeys, and other fixed per-acre items must be prorated over a much smaller volume of timber.

A comparison of tractor A with tractor B costs shows the advantage of direct yarding except where the topography necessitates cable yarding. A "skid" tractor has a big advantage over the double drum wherever it can be used because of its much greater flexibility and mobility.

Range Research

Pine Ranges

Compilation of Pine Range data is pointing out that the number of samples or cases needed to obtain reliable averages of plant measurements (say averages in which $2.5\sigma_M$ = 5 percent of the mean) depends on the type of measurement and upon the plant species under consideration. Although the data available to make this point clear are quite meager, yet the trends are evident. The values shown below are rounded to whole numbers:

I	II	III	IV
Type of measurement and species	No. of cases or measurements per unit of plant	Percent Reliability of average $\frac{2.5\sigma_M}{M}$	No. cases needed when $\frac{2.5\sigma_M}{M}$ = 5%
A. Dry Weight			
Wyethia mollis	50	17	
Festuca idahoensis	100	13	734
B. Average Height			
Wyethia mollis	50	6	
Festuca idahoensis	100	3	34
C. Basal area			
None of Wyethia			
Festuca idahoensis	100	11	464
D. Moisture content			
None for Wyethia			
Festuca idahoensis	25	5	25

Columns II and III show that if the desired accuracy ranges between 10 and 15 percent, the number of cases needed is 100 or less. This is in marked contrast to the values in column IV where 5 percent accuracy is maintained. For example, to attempt 5 percent accuracy in all types of measurements for fescue entails a lot of field work. But with information known, such as that given above, 10 or 20 percent accuracy may be deemed satisfactory depending on the experiment, and the number of measurements that have to be made can be materially cut down.

Erosion-Streamflow

Watershed Studies - San Dimas Experimental Forest

1. Records: Three heavy storms occurred providing unusual activity. The first, on February 1 and 2, yielded approximately 4 inches of rain; the second, from February 10 to 20, gave an average of 11 inches; and the last, 2 inches on February 22 and 23. These storms were exceptionally heavy throughout the State and have brought the average for the State considerably above normal for the season to date.

In connection with our vegetation studies twelve plots have been established for continuous phenological observations. A total of 80 eight-milacre quadrats have now been measured in the Bell multiple watersheds, for a study of optimum quadrat size for chaparral vegetation surveys.

2. Installations: New recorders have been installed at all of our small debris reservoirs, to improve the accuracy of these flow measurements.

A four-foot Sam Dimas flume, installed at our large gaging station Viii, has remained clean and given a continuous flow record in spite of heavy bed-load contents in storm flows.

The new intra-forest telephone system is proving a great aid in coordinating staff activities in maintaining our research installations during storm periods.

Watershed Studies - Kings River Project

Construction on the Kings River Watershed project was materially delayed because of the unprecedented rains which lasted for nearly two weeks during the middle of the month. An average of about 180 men per day was used during the working period. Up to February 22 progress on gaging stations showed excavation about 20% complete on unit watersheds 4, 5 and 6 in the Big Creek area of the digger pine type. Other work included cutting of fence posts of cedar in the Sierra National Forest; the erection of telephone line from Kings River Dam to the experimental watersheds 85% complete; contour map of entire area 80% complete; erection of incline and cables preparatory to pouring of concrete of dams at unit watersheds 30% complete.

Erosion Survey

We received from the Soil Conservation Service a preliminary report on their survey of sedimentation in Morena Lake, San Diego County, California, and a statistical summary of their Lake Hodges survey.

The sedimentation in these reservoirs as shown by the survey amounts to about 3800 cubic yards per year per square mile of drainage area for the Morena reservoir and 900 for the Lake Hodges reservoir, which has reduced the reservoir storage capacities by 0.409% and 0.440% per year respectively.

The next step on these projects is the examination of the watersheds to trace the sources of erosion with a view of interpreting the deposits in the reservoirs. This step will be done cooperatively by the Experiment Station and the Soil Conservation Service, employing the standard methods used by the Soil Conservation Service in other parts of the United States, with such modifications as are necessary for California conditions. Since these watersheds are entirely within National Forest boundaries the final step of prescribing corrective measures will be done by the Forest Service. The final report, covering the sediment measurements and watershed examination will be prepared as a joint report by the Experiment Station and the research branch of the Soil Conservation Service. This plan of action in this instance is in pursuance of instructions contained in the Secretary's memorandum of June 5, 1935 in which rules were laid down for cooperation of Soil Conservation Service with other bureaus of the department.

Erosion Control - Plant Propagation Studies

With the WPA help available this month, Mirov's work on propagation of selected species to be used for landscape planting has advanced considerably. The Gill Tract greenhouse and nursery are being brought to the condition necessary for the propagation of plants on a large scale.

In planting willow cuttings at different depths, it is of interest to mention that the cuttings planted three inches below the ground are sprouting very satisfactorily. The conclusions regarding the most desirable depth of planting willow cuttings will be drawn at the end of next summer when the root-top ratio will be studied.

Erosion Control - San Jacinto River Project

River bank and levee planting on the San Jacinto River was resumed in January by the San Bernardino Forest under general supervision of Ilch of the Experiment Station. This year's work includes the replacement and extension of failed plantings on Bautiste Creek, tributary of the San Jacinto River. In the 1934 and 1935 plantings, Baccharis and tamarisk had a much higher survival than willow, and Tamarisk showed a higher rate of survival than Baccharis. The majority of dead cuttings of all species were only 8 to 16 inches in length with as much as 4 to 6 inches of the cuttings exposed. A number of the living cuttings were excavated and all were found to be 20 inches or longer with a minimum of 18 inches in the ground. The character

of the soil, which is largely river sand and gravel, necessitates planting the cuttings to a minimum depth of 18 inches in order to place the expected root zone below the zone of complete evaporation which normally extends to a depth of 12 to 14 inches.

Based on these observations and similar experiences in forest planting in southern California, this year's planting is being limited to cuttings of Baccharis and tamarisk of a size at least 1/2 inch in diameter and from 24 to 30 inches in length. All planting was done by a 25-man crew from the San Jacinto Camp under a foreman trained for several years in the Experiment Station. In a 12-day period, a total of 10,000 cuttings had been gathered and planted by this crew.

Fire Research

Lorenzen designed and has completed the first of seven tripods to be used with Byram Type anemometers in the study of wind movements on test fires. The tripods are all metal with legs of seamless steel tubing and the other parts of brass and aluminum. The special feature of the tripods is a gimble suspension for the anemometer which eliminates the necessity of leveling the instrument each time it is moved.

The laboratory investigation of methods of determining the moisture content of forest fuels has been continued with the accumulation of some valuable data. Present indications are that we will be able to select a much more satisfactory method of determining moisture content than that involving the use of conventional drying ovens.

Analysis of the data collected last summer on the variations in the moisture content of needles under ponderosa pine stands is nearly complete and summaries of the results obtained in the various phases of the work are being prepared.

Forest Products

Logging and Milling Studies

Part I, "Field Procedure", of Brundage's manual on "Field and Office Procedure Adapted to Logging and Milling Studies in the California Pine Region" was issued in multilith edition and distributed. The manuscript for Part II, "Office Procedure", is scheduled for issue during June.

The lumber-grade production from the redwood milling study conducted last June has been summarized by grades without reference to lumber sizes. Selling values were computed for several sample logs of each grade, using the board-size price variations. These are much greater than in pine. The log of lowest value in the sample

analyzed was worth $12.35 per M B.M. mill tally. This was a 35-inch log graded as #4 with the bark intact. The highest value was #36.70 per M tally for a 72-inch grade-1 log. The selling prices used were the western green-lumber prices in effect the latter part of 1935. Eastern dry-lumber selling prices are $3 to $5 per M higher than the western figures.

The mill-production study of lumber from ponderosa and Jeffrey pine bug-killed trees, conducted in cooperating with the Bureau of Entomology and the Regional Office, is being summarized. In addition to log-grade and size classes, the logs are segregated in accordance with an insect classification based on the stage of development of the broods at the time of cutting.

Economics

Land Use - 5 County Study

Analysis of case records of foothill livestock ranches has been started to determine the effects of land character and vegetation cover on grazing utilization and returns. Ranch incomes are being related to such factors as amount of pasture, expressed in both surface and forage acres, to amount of supplementary feed, to numbers of livestock, and amount of rentals. Meat production is being related to such factors as carrying capacities, livestock inventories, and systems of ranching. The effects of taxation on land utilization are also being determined by correlating carrying capacities and rentals with assessed values.

CENTRAL STATES FOREST EXPERIMENT STATION

Forestation

Seed. The winging and cleaning of samples of shortleaf, pitch, and Virginia pine seed from Vinton County, Ohio, was completed by R. Myer. B. Myer finished the weighings of black locust seed and is now making the records on the various samples of pine seed. Cutting tests indicate very poorly filled seed from cones maturing in 1935.

R. Myer stratified about 9 bushels of yellow poplar seed collected by the E.R.A. crew in Ohio. He had just completed tacking down frames over the seed when flood waters, backed up by an ice jam in the Scioto and Olentangy rivers, covered the beds, rising to a depth of 4 or 5 feet. Fortunately the water went down in a few hours with a breaking of the ice jam.

Forest Soils

Auten spent the major part of the month in testing soils from the Vinton County, Ohio, experimental plots. He plans to make a study of the seasonal changes in pH and oxidation potentials of the soil of that area. By taking advantage of the extremely cold weather, he was able to secure soil samples whose biological activity should be at its lowest ebb. These measurements should give contrast to those taken later in the year.

In connection with the soil sampling, some interesting data were secured by Cochran with his E.R.A. crew. In spite of a month of very cold weather, during which the thermometer fluctuated around zero and was at one time reported at 30° below, there was no frozen soil in the woods. Where the snow had been blown off in the fields the frost was 16 inches deep. The snow fell in the beginning on wet ground, and it might be said that there was no frost anywhere, forest or field, where the snow was 5 inches or more in depth.

Forest Management

It is planned to initiate a study of cull per cent and growing stock appraisal in southern Illinois during March. Ralph M. Lindgren, of the division of forest pathology, has been interested in this project, and visited the Station to discuss it. E. R. Roth, pathologist now assigned to the Milwaukee office, has carried on similar studies in West Virginia and in Missouri, will cooperate in the Illinois project, which will be financed largely by emergency funds until July.

Farm Woods. Diller has found some opportunity, during his E.R.A. assignment in Arkansas, to compile many of his plot records and remeasurement data obtained last summer from the Indiana plots in grazed woods.

Forest Insect Investigations

Hall and Cummings have devoted the month of February exclusively to statistical work on field data with further analysis of mulching data and locust borer survival records. The effect of mulching on the Cambridge plots for 1935 does not appear to be as marked as during the 1934 season, presumably due to the higher and more uniform precipitation during the past season.

Further analysis of locust borer survival records for the past four field seasons indicates a high degree of correlation between tree diameter and survival, as well as between annual increment and survival. The relationship between tree diameter and survival is inverse, with survival of borers decreasing with increasing diameters. It appears from this preliminary analysis that the correlation between tree diameter and borer survival is uniformly higher than between annual increment and survival.

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Range Investigations
Summer Range

Artificial Reseeding, Common Bromegrass

Previous investigators have shown that common bromegrass (Bromus inermis), an introduced creeping grass, is a valuable plant for range reseeding on soils that are fairly moist and not too shallow or rocky. Results of recent reseeding trials, made on an oakbrush type range in the vicinity of the Great Basin Branch Station in central Utah, extend the use of this species to sagebrush swale types on this type range.

Of a total of sixteen tests made with common bromegrass, six were entirely successful, eight were partially successful, and only two were failures. Of the fourteen tests having some degree of success, eight were sown in the spring and six were sown in the fall; eleven were sown broadcast on plowed furrows and covered with a brush drag, two were sown broadcast on bare ground and trampled with sheep and one was sown broadcast on bare ground with no further treatment. All of these plots produced excellent foliage growth and matured viable seed, each having a germination exceeding 90 percent.

Common bromegrass also was practically equally successful at three different elevational stations within the oakbrush zone. Tests were made at elevations of 7,150 feet with approximately 12 inches annual precipitation, 7,890 feet with approximately 7 inches annual precipitation, and 8,000 feet with approximately 20 inches precipitation. The carrying capacity of the test plots in these areas was increased from 44 percent to more than 900 percent depending upon the degree of depletion of the plots.

SPRING-FALL RANGE

Comparison of Data From Friez 3-Cup and Robinson 4-Cup Anemometers

This station in the past has used the 4-cup type Robinson anemometer but recently has purchased several new Friez 3-cup instruments. In order to test the similarity or dissimilarity of data from the two types of instruments, one of each was installed at the U. S. Sheep Experiment Station and 24-hour readings were taken from March 21, 1935 until November 4. The daily record was broken several times by the absence of observers for periods of one to several

days, but by accumulating the total miles of wind by 5-day periods and obtaining average daily velocities for these periods an unbroken record was secured.

Correlation of the data from the two instruments summarized in this manner gave a coefficient of ± .963 ± .011, indicating a nearly perfect linear fit between the two sets of data. Regression of the 3-cup (X) in the 4-cup (Y) was 0.88Y - 1.9. The second regression (Y and X) was 1.06X ± .16.1. Since future records will be taken with the new Friez 3-cup, it is probable that conversion of 4-cup velocities to the 3-cup standard will be desirable. From these data the standard error of estimate of X.Y was found to be ± 8.45 miles of wind per day on a mean of 181.9 miles. Actually, using the regression 0.88Y - 1.9, 77.3 percent of the estimations of 3-cup velocities from 4-cup readings fell within this range and only two were greater than 50 percent of the standard deviation of the 3-cup (± 31.38). It is apparent that no great error will be created in converting 4-cup to 3-cup velocities.

DESERT SHRUB RANGE

Forage Production on the Winter Range

Since 1931, when investigations began on the winter ranges of western Utah in the general vicinity of the Desert Experimental Range no season produced a good forage crop. During 1935, however, sufficient precipitation occurred to produce approximately normal forage growth.

A series of pasture studies is just now being completed to show the actual amount of growth during the last season. Not only was the amount of forage produced during 1935 greater than anticipated, but on several of the species, particularly Indian ricegrass and shadscale, a good seed crop added greatly to the feed value of the stem and leaf growth. The large seeds on these two species seem to be especially rich in nutrient material. Something more or less equivalent to a small grain ration is apparently made available to the animals in the abundant seed supply of both these species.

There was a very small seedling production during the last 10 years or more. It is hoped that the good 1935 seed crop may change this situation.

ARTIFICIAL RESEEDING

Plans are being perfected to conduct, as soon as spring opens, a thorough going research program in artificial reseeding in cooperation with the Bureau of Plant Industry, and the Utah State Agricultural Experiment Station. Work on this project will fall into two main divisions:

1. Soil classification.
2. Plant adaptation.

Soil Classification

A comparatively small amount of research has been done on the suitability of soils of different qualities for range improvement by artificial reseeding. It is known that the really valuable perennial grasses succeed only on the more fertile soils which possess favorable waterholding properties as well as a considerable percentage of plant nutrient material. In general, forage stands have been obtained after reseeding on these deeper, more productive soils, but on the other hand there has been a more or less general failure on soils that are poor in nutrient material and that because of being shallow have low waterholding properties.

Up to the present observations have been very general. It is now planned to make a rough survey of the quality of the soils that exist in those parts of the Intermountain region that seem most suitable for artificial reseeding. The depth of the soil and the amount of organic matter it contains, together with some of its chemical properties, seem to be the more important qualities upon which range soils need to be classified. It is not possible to make soil survey maps or to do other things that require a like amount of work. It seems absolutely necessary, however, to grade these soils into three or four major groups, according to whether they will support grass rather freely, whether they will support grass only in smaller quantities along with some weeds, or whether they are capable of supporting only weed forage plants. A considerable area of the most depleted soils appear at first glance to be capable of supporting only annual weeds.

After soils are roughly classified according to these major qualities, a study is being planned to determine which plant species are most suitable for reseeding on these various soil conditions and which, at the same time, are likely to be most serviceable for grazing, or for watershed protection, or for both.

Plant adaptation

It will take many years fully to analyze the adaptation of the various plant species that are available for reseeding. In the end it is planned to bring importations from foreign countries and, by means of crossing, to manufacture new plant varieties by combining the desirable qualities of native species with other desirable qualities carried in imported plant sorts. For the immediate future, however, reseeding experiments will be conducted with the species that are available in large quantities. It is planned to make a considerable number of research plantings with crested wheatgrass, smooth bromegrass, and western wheatgrass, and a smaller number with other species which seem to have promise.

Details of the plans in this experiment are not yet completed but are being prosecuted now with all possible vigor. It is expected that a full-time man will be assigned to this project in the near future and as rapidly as possible he will be given additional help.

EROSION-STREAMFLOW INVESTIGATIONS

Boise Erosion Project

Soil Fertility and Texture Losses

The extent to which the surface half inch of granitic soil on the Boise River watershed may be depleted of soil nutrients and changed in texture as the result of a single heavy rain was determined during the past two seasons by means of portable apparatus. The results of analysis of silt and soil samples taken immediately before and immediately after the application of 1.80 inches of artificial rainfall on 96 plots are shown in the table below.

The average percentage loss of mechanical fractions and fertility by the surface one half inch of soil on 96 plots resulting from one artificial rainstorm of 1.80 inches.

	Fractions Analyzed					
Conditions of Sampling	Gravel	Sand	Silt	Clay	Organic	Nitrogen
Surface soil before rain	39.4	43.9	8.8	4.3	3.4	0.2
Eroded material	24.4	41.2	21.8	8.2	5.1	0.3
Soil remaining after rain	46.5	38.2	8.4	4.0	2.8	0.1

An inspection of these data show the following changes:

1. The eroded material contained only 24.4 percent gravel while the gravel content of the soil increased from 39.4 percent before the rain to 46.5 percent after the rain.

2. There was no material change in the sand fraction.

3. The eroded material contained 21.8 percent silt while the silt content of the soil decreased from 8.8 percent before the rain to 8.4 percent after the rain.

4. The eroded material contained 8.2 percent clay while this fraction of the soil decreased from 4.3 percent before the rain to 4.0 percent after the rain.

5. The eroded material contained 5.1 percent organic matter while this material in the soil decreased from 3.4 percent before the rain to 2.8 percent after the rain.

6. The eroded material contained 0.3 percent nitrogen while this important element in the soil decreased from 0.2 percent before to 0.1 percent after the rain.

Although the losses from the surface soils here described were caused by a relatively heavy rainstorm, the results indicate the manner in which the granitic soils of this locality are changed as a result of erosion and the rapidity with which this change may occur. A single rainstorm not only caused a definite change in the texture of the surface soil, but of greater significance from a rehabilitation standpoint, the preferential loss of nitrogen and organic matter resulted in a serious depletion of those elements which are of major importance in the fertility of the soil. This study in part at least, suggests the manner in which extensive areas of range land on the Boise River watershed have been depleted of essential plant nutrients and emphasizes the necessity of intensive erosion control measures as a basis for conserving the range-watershed resources.

Some Range Watershed Values in Utah

One of the most striking examples of the water problem and the value placed on water by valley communities in Utah is illustrated by a study made in the suburban area between Farmington and Centerville in Davis County, Utah. The small creeks that flow from the mountains in this area seldom, if ever, flow more than one-half second-foot during the critical water period in July and August, yet the book value of this water may be as high as $50,000 from single canyons having drainage areas of only 1,500 to 2,000 acres (table 1). The table also shows that the value of streamflow per acre of watershed above 7,000 feet varies from about $13 in the case of Davis Creek to $104 in the case of Centerville Creek, with an average value of about $39 per acre.

Table 1. Showing the book value of water by drainages and the approximate value of streamflow from each acre of watershed above 7,000 feet elevation.

Name of Creek	Watershed Area		Stream Flow Value	
	Total	Above 7,000 feet	Book Value	Per acre yield above 7,000 ft.
Centerville	2,020	1,120	$ 50,000	$ 46
Parrish	1,373	810	30,000	37
Barnard	889	370	38,400	104
Ford	1,507	1,450	50,400	35
Davis	1,005	600	7,600	13
Steed	1,763	1,010	33,600	33
Average value of water per acre of watershed above 7,000 ft. $39.18				

LAKE STATES FOREST EXPERIMENT STATION

Annual Investigative Meeting

The plans for the annual investigative meeting with Region 9 have been perfected. This year the Central States Station will join with the Lake States, and the meeting will be held in Milwaukee, March 18-30. The new Regional Forester, Mr. Lyle F. Watts, formerly Director of the Northern Rocky Mountain Station, will have arrived by the time scheduled for the meetings and a very satisfactory conference is anticipated.

Forest Planting

On February 20, Rudolf presented a paper before the Society of American Foresters. The subject was "Forest Plantations in the Lake States - An Appraisal." An account of the more important factors affecting forest planting in this Region was given, based on results from work at several of the branch stations, and on last summer's resurvey of older plantations in Wisconsin.

Meeting of Minnesota Nurserymen

On the afternoon of February 11, a meeting of the Twin City and State Nurserymen's Association was held at the Station. In spite of the cold weather, -12°F., 30 members were present. The chief purpose of the meeting was to acquaint the nurserymen with the work being done by the seed laboratory. All the phases of the seed work were demonstrated, including germination, pre-treatment, determination of dormancy, and the effect of seed origin on drought resistance of green ash.

Fisher, Shirley, Briggs, and Meuli gave short talks on seed testing, methods of overcoming dormancy and the importance of seed source. The proposed seed manual was explained and aroused considerable interest. The enthusiasm of the nurserymen was displayed by their many questions both technical and general.

Seed Testing

A tabulation of seed testing to date shows that 344 samples of seed have been submitted for testing, 56% from Shelterbelt nurseries, and the balance from Region 9. This increased load of regional seed has come for the most part from nurseries in the many new Purchase Units in the Region. These routine tests will be completed and reported in sufficient time for the nurserymen to have the benefits of the results for planning their spring sowing.

In addition to routine testing, studies have been carried on of storage, pre-germination treatment with organic hydrins, scarification, stratification, and new testing methods.

New Road System on the Kawishiwi Experimental Forest

The CCC's have about completed a ten mile utilization road system on the Kawishiwi Experimental Forest on the Superior National Forest. Although this does not seem like a very large project, the numerous swamps and rock ledges made the work difficult.

Use of Prison Labor in Conservation Activities

Since prison labor has been used for conservation projects in Wisconsin, with considerable success, it has lately been proposed to supplant the CCC laborers used at the Upper Peninsula Branch Station, with prisoners from the state institution at Marquette, Michigan. Where this type of labor can be used without competing with free labor and in out-of-the-way areas where no reasonable objections from resort owners and tourists need be expected, its use is to the advantage of the prisoners and to society as a whole. At the Dukes Station, however, where there is an adequate supply of free local labor needing stable employment, the use of prison labor would defeat one of the primary aims of forestry at this demonstration forest. The presence of many resorts and the nearness of main highways is also a deterrent to the use of such labor at the Upper Peninsula Station.

Shelterbelt Influences

The study of wind movement as affected by artificial barriers has been continued despite the extreme weather conditions during the month. At the North Dakota set-up near Towner, the temperature one day reached a low of -56°F., the lowest reading for any weather station in the United States on that day. At Huron, South Dakota, snowfall has been very heavy and drifts have formed over the barriers. This has furnished excellent data on the drifting of snow but has made the continuance of the study of wind movement practically useless until the snow drifts settle a great deal since the wind has a tendency to follow the contour of the snow instead of the ground surface.

NORTHEASTERN FOREST EXPERIMENT STATION

General

Meetings

Behre attended the annual meeting of the Society of American Foresters in January and presented a paper on "The Part the South May Play in Meeting National Newsprint Requirements". In this paper he cited experience of the Northeast in depletion of second growth stands as a warning to the South on the possible result of indiscriminate and uncontrolled utilization of the young timber which now appears so abundant in that region.

At the winter meeting of the New York Section in Albany on February 7-8, considerable interest was shown in a paper by C. R. Lockard which described the objectives and scope of the Station's study of the basis for cooperative forest management and utilization at Cooperstown, New York. In the discussion it was stated by foresters outside the Service that the success of the Cooperstown project represented a challenge to the profession of forestry and for this reason merited the wholehearted cooperation of all forestry agencies in the state.

At the winter meeting of the New England Section in Boston on February 20-21, activities of the Northeastern Station and the cooperating bureaus also played a prominent part. In connection with the report of the Committee on Silviculture, Westveld presented a chart showing the results of the latest remeasurement of the girdling experiment at Corbin Park, New Hampshire. This experiment is now 30 years old and the remarkable growth of spruce pulpwood on the treated areas where the timber is rapidly coming into the merchantable size classes created much comment. Numerous requests for data have come in since the meeting. It is planned to release the chart as a technical note in the near future.

Doctor Spaulding presented a report for the Committee on Tree Diseases. This called attention, among other things, to the recrudescence of the European larch canker in Massachusetts.

Continued investigations of Nectria canker reveal that young twigs, sprouts and seedlings may be naturally infected and tiny bark covered cankers form, even bearing fruits of the fungus. As added knowledge becomes available regarding the distribution and occurrence of the Nectria cankers, the more evident is the fact that this disease is an important factor in forestry in the Northeast. Spaulding suggested that experimental cuttings in various forest types and sites in blocks of 5 or 10 acres each with records of the condition of the felled stand and of the new stand at suitable intervals be

begun to determine under what site conditions various types of cutting may be effective in diminishing Nectria canker.

Mr. Baker of the Bureau of Entomology and Plant Quarantine presented a paper showing the significance of stand composition in relation to the recent epidemic outbreak of gypsy moth in central Massachusetts. Intensive study of the town of Petersham, Massachusetts, showed that without exception the areas seriously defoliated supported a stand in which the most favored food species, principally gray birch and poplar, constituted a dominant part. Serious defoliation was repeatedly observed to stop short along the margin of stands from which these undesirable favored food species had been removed in previous years by cultural treatment. As a result of this study, renewed emphasis is being given to stand improvement in gypsy moth control operations by the Bureau of Entomology and Plant Quarantine and the Civilian Conservation Corps. A pamphlet outlining the principles for such silvicultural control measures is now in preparation by the Northeastern Station, the Bureau of Entomology, and the Harvard Forest.

Forest Economics

Private Forestry

Analysis of over 1,000 increment borings taken from the woodlands adjacent to Cooperstown, New York, establishes the fact that current growth is somewhat in excess of 3% and lends confidence to the marking policy which is being suggested as a basis for management under the cooperative plan. The marking aims to remove trees of lowest vigor in all size classes to the extent of about 10% of the stand. The growth study confirms the adequacy of the marking in that radial growth on the trees to be left is about 50% greater than growth on those marked for cutting. Since removal of the least vigorous element of the stand tends to raise the average growth rate, it is anticipated that cuttings which remove about 10% of the stand can be made at three year intervals.

The correlation of radial growth with diameter is of little significance in these woodlands. There is, however, a significant difference between growth on the west slopes as compared to east slopes and ridge-tops, the latter being only about 3/4 of the former. It appears that the common northern hardwoods, beech, yellow birch, sugar maple, and soft maple may be grouped together but that red oak and white pine must be treated separately as their growth averages considerably higher than the northern hardwoods.

Pulpwood Production Costs

The Pulpwood Production Costs study, initiated during the summer of 1935, was conducted on seven representative jobs. Stop-watch timing data were taken covering all woods operations, including piling of the pulpwood bolts. The D. I. B.'s of all bolts were measured as bucking progressed and when piles were complete, all D. I. B.'s in each pile were measured.

After the first snowfall, timing data were taken on yarding and hauling by truck to the mill.

Costs to the landowners for all operations let on contract were as follows:

Felling) Limbing) Peeling) Bucking) Piling)	$2.75 to $3.00 per cord	Majority of owners paid $3.00 per cord
Yarding)	$0.50 per cord	
Hauling)	$1.25 to $1.75 per cord	Price paid for hauling varied with length of haul.

A table was prepared presenting basal areas in square feet for diameter from 1.0 in. to 18.0 in. and cubic ft. volumes of cylinders, the products of these basal areas and the lengths of 3.8, 3.9, 4.0, 4.1 and 4.2 feet. This table was then converted into a double alinement chart as follows:

ALINEMENT CHART
for use in pulpwood studies

Presenting cubic ft. volumes of pulpwood sections of top D.I.B. 3.0 - 18.0 in. and length of 3.8 - 4.2 ft.

DIB	3.8	3.9	4.0	4.1	4.2	DIB	3.8	3.9	4.0	4.1	4.2	DIB
3.0	.187	.191	.196	.201	.206	3.0	.187	.191	.196	.201	.206	3.0
.1	.199	.204	.210	.215	.220	.1	.199	.204	.210	.215	.220	.1
.2	.212	.218	.224	.229	.235	.2	.212	.218	.224	.229	.235	.2

In use, a line across the D.I.B.'s for the second and first bolts in a tree will give from the chart, the volume of the second and first bolts and the stump D.I.B., disregarding butt swell which was found to be a negligible factor in computing utilization volumes. Variation in measuring of lengths by bucking crews made the several length columns necessary.

The total D.I.B.'s in 72 piles were analyzed statistically. The solid wood content of each pile was computed and compared with gross volume. On the basis of 55 piles, this relationship was .68996; or solid wood ran about 69% of gross volume per pile. In terms of cords, this would amount to 88.3 ± 5.359* cubic ft. solid wood content per scaled cord of 128 cubic ft.

Analysis of the timing data has not yet begun, for these data will not be complete until additional data are collected during the coming season. Much information useful to individual land-owners, company operators and others interested in the production of pulpwood, may be obtained when the results of the present study are made available.

Management

A fairly rapid and efficient method in making reproduction counts on milacres supporting large numbers of seedlings (50,000 or more per acre) was developed during the course of last season's work.

In studies dealing with reproduction it often happens that milacres support large numbers of seedlings of the current season's origin, usually following heavy seed years. This was particularly noticeable in the germination of red spruce and yellow birch seedlings on the Corbin Park, N.H., area during the past season. To count each individual seedling on the milacre would be a difficult task and would entail a large amount of time. This difficulty was obviated during the past field season in remeasurement work on spruce plots in Corbin Park, New Hampshire.

The number of seedlings on each milacre was expressed in percentages with an arbitrarily chosen standard of 100 percent representing a condition with one seedling per square inch.

A square hole was cut in a heavy grade of paper, each side of the square being 3.16 inches, resulting in an opening containing 10 square inches. This was allowed to fall ten times (by chance) over the milacre, 5 times on each half, and the seedlings within the square counted each time and finally totaled. This total figure gave the percentage number directly and represents the number of trees per 100 square inches.

The conversion of this percentage figure to the number of individuals per milacre is very simple. There are 6272.64 square inches in a milacre. If the percentage number is 100, then there is one seedling per square inch or 6272.64 seedlings on the milacre. Therefore, one percent would be 62.73 seedlings per milacre, 2%--125, 3%--188, etc.

* Probable error

When there were less than 60 seedlings (ocular estimate) per milacre, the task of counting them was not great, so the actual number of individuals was determined and tallied.

Permanent Sample Plots

Both Reineke and Morey have been devoting time in assembling the mass of permanent sample plot records (for about 700 plots) in accordance with a system devised to facilitate field use and planning of remeasurement field work and to provide adequate safeguards against oversights in the collection of remeasurement data.

One phase to which Reineke is devoting his attention to particularly is the establishment of a definite plan for photographs of permanent sample plots and the development of a suitable technique and equipment for the taking of the pictures. In this connection permanent markers or targets are being designed to be used in aligning the camera by reference to lines on the ground glass and methods of determining or marking the camera positions. Equipment can be developed along the lines of a camera support in the form of a ball-and-socket tipped Jacob staff of a fixed length to be inserted in a pipe placed on the ground, the pipe to be fitted with a removable cap above ground to keep out water, and a flange at the bottom to prevent frost heaving. A platform atop the staff, fitted with levels, compass and guide strips, could be employed for the camera and used for either stereoscopic views or ordinary views.

During the remeasurement of a series of sample plots at Sharon, Vermont, Morey detected a peculiar type of damage to beech which he attributes to the use of calipers. The trees were calipered in 1904 and 1915, the point of measurement being indicated by paint spots. Many of these points had callus growth of a thickness to 1/4 inch. At first it was believed that the paint may have caused the damage, but later observations eliminated the paint theory. Several times no paint spots could be observed, but examination would show portions of two pairs of callus at right angles to each other, indicating the point of measurement. By experimenting with a pair of calipers, we could see how the damage might occur. Apparently, the slight tap caused by closing the caliper arms on the thin, live-barked beech is sufficient to cause this wounding. If the callus is large enough, considerable error may result in the diameter growth records for the species. This damage was not observed on any other species.

Entomology

Laboratory experiments have been conducted throughout the winter on the European Spruce Sawfly. Under laboratory conditions eggs hatched in about one week, and the period between egg-laying and spinning of the cocoons varied from 33 to 43 days. In a room where the temperature and relative humidity were held constant at 75° F

and 66% respectively the adult females emerged from the cocoons in as short a time as ten days. The significant fact is that, under favorable conditions, a generation can complete development in approximately six weeks. This indicates the probability of more than 2 generations per year in the southern part of the range of the insect.

Correlation of the data collected in the study of the cause of the dying back of oak twigs in central Massachusetts, by Hansbrough and MacAloney, shows that definitely 128 of the 500 tagged trees died from late spring frost or winter injury. Only 17 were killed by insects alone and secondary fungus infection was found in 3 dead twigs late in the season.

NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

General

On February 24, bids were opened for the construction of the new addition to the Forest Service building at Missoula. This building, when completed, will furnish adequate space for the Station as well as the Region One headquarters office. Six hundred thousand dollars has been appropriated for the construction of this building.

From Deception Creek comes the report of a minimum temperature of 36 degrees below zero on the 13th of February, 1936. The greatest depth of snow recorded to date at the station is 5.7 feet with the chances of an even greater depth before the winter season has run its course. William Galbraith, caretaker at the Deception Creek Experimental Forest, did not mention the number of feet of snow at the higher altitudes, perhaps for fear of discouraging all prospective visitors between now and when the roads are opened in the spring to automobile traffic. He writes that no roofs have caved in as yet, but adds that he has been plenty busy shovelling snow to prevent a disaster.

The most important development at the Station during the month was the selection of Director Watts as Regional Forester of Region Nine. Mr. Watts will leave to take over his new assignment shortly after the 15th of March. Congratulations to Region Nine!

Range

February will be long remembered as a month of extreme and sustained cold weather in Montana with more than normal snow in most portions of the State. It is reported that range livestock losses have been heavy. Despite generous use of hay to supplement range forage, 7 of our 60 experimental cows died from exposure on the range at Miles City. These are the first losses experienced during the four winters that this experiment has continued.

The bulk of the 1935 field data has now been compiled and analysed and will be available for the annual investigative meeting this month. Woolfolk will leave for Miles City to resume fencing work for the sheep project. The ERA quota to the Custer which we were depending on to complete this job has been used during the winter so that completion of the fencing work necessary to start the sheep project depends on a supplemental ERA allotment. Plans for this project will be seriously delayed unless this supplemental allotment is approved in March.

Results from artificial reseeding work done in the spring of 1935 and in the fall of 1934, and even for some work done previously, were often indeterminate when examinations were made last fall. This was due to another very dry summer and fall in 1935. Helena experienced the least precipitation in more than 50 years in 1935 while 1934 was the record drought for the Miles City region. It would have been difficult to pick two more unfavorable seasons for successful reseeding of range lands. Those areas that failed to show an average of 2 or more live seedlings per square yard were classed as failures though it is expected that some of these may prove successful with a favorable spring in 1936. From the fall of 1933 to the spring of 1935, inclusive, approximately 1,150 acres have been reseeded mainly on private lands under cooperative agreements, but a considerable acreage was reseeded on National Forest areas and at the U. S. Range Livestock Experiment Station near Miles City. This project is largely on an extension basis financed by emergency funds. Of the total acreage seeded, 23 percent was classed as successful last fall based on the best available data. Crested wheatgrass was at the top of the list with 31 percent success on more than 700 acres. The fall seeding of crested wheatgrass has given 39 percent success to date as compared to 26 percent for spring seeded areas. Slender wheatgrass on a much smaller acreage ranked next with 25 percent of success with little difference between spring and fall seeding. Complete failure or very low degree of success resulted from other species tried.

Fire Research

The event-of-the-month, for February, was the Spokane meeting devoted to fire control. One of the 28 topics on this program was assigned to Hornby, while Gisborne handled two.

This meeting was exceptionally valuable to our fire research men by (1) producing suggestions and criticism by administrative officers, (2) by displaying side by side the types of fire research under way at the various stations, (3) personal contacts, and (4) formation of plans for more intimate exchanges of information in the future.

After the Spokane meeting Mr. Headley spent the better part of two days in Missoula studying carefully the danger measurement and fire control planning methods developed by our Station. Plans were made to continue the testing of frothy mixtures, started last year, as these mixtures may be of value in the aerial retardation experiments to be made by the Washington Office of Fire Control.

During February an airtight box was constructed for the calibration of hygrothermographs. Any natural combination of temperature and humidity can be produced and maintained in this box. By its use the instrumental error resulting from comparison of records from numerous hygrothermographs can be reduced materially. This piece of

equipment, costing about $60.00, is part of the systematic plan for testing all instruments used by this Station, from tapes and compasses to scales and thermometers.

Forest Products

Requests are received frequently for information on "the percent of total volume represented by the butt log, the second log, the top log." Such information has numerous applications. For example, cruisers wish to know what percent of total volume the butt log represents, particularly when the basal logs are highly defective. Or silviculturists, conducting experiments in artificial pruning, may wish to know what percent of volume is represented by the lower part of a bole which was pruned. Such figures are given in the following table:

Percent of merchantable volume represented by butt log, second log, etc., for western white pine trees. 1/

Log Position in Tree	Number of merchantable 16-foot logs per tree						
	2	3	4	5	6	7	8
	(Percent of gross merchantable volume)						
Butt	55	43	35	31	27	25	25
2	--	33	28	25	23	21	20
3	--	--	21	20	19	18	17
4	--	--	--	15	15	14	14
5	--	--	--	--	10	11	10
6	--	--	--	--	--	7	7
7	--	--	--	--	--	--	4
Top	45	24	16	9	6	4	3
Total	100	100	100	100	100	100	100

Based on 641 trees, 10 to 35 inches in diameter, from White Pine Lumber Company plot.

1/ These figures apply equally well to small or large trees. Height (number of logs per tree) influences the percentages but diameter does not. This indicates that for a given height class, the trees have approximately the same shape (form factor).

Anderson returned to the office February 8, after spending five weeks in Region Three on a logging and milling study at the Mc Nary, Arizona, plant of the Southwest Lumber Mills, Inc. At the request of the Division of Forest Management of Region Two he spent three days on an inspection of the Montezuma Lumber Company sawmill and woods operation at McPhee, Colorado. One of the reasons for this inspection was to make a rather extensive investigation of sawmill

practices in an effort to determine reasons for the lack of overrun. Two major contributing factors were isolated: (1) one double rotary headsaw where the smaller logs were sawed with saws swaged to 9/32nds of an inch, and (2) excessive lumber thickness setups on headrigs. This latter factor alone accounted for a loss of at least 9 percent in overrun at the McPhee plant. The following table shows a comparison of the range in thickness of rough green inch lumber.

Range in thickness of rough green inch lumber

Headrig Setup	Thickness in 32nds of an inch											
	28	29	30	31	32	33	34	35	36	37	38+	
	%	%	%	%	%	%	%	%	%	%	%	%
Normal Inland Empire Practice 32/32	.6	3.8	5.6	31.2	27.5 1/	21.9	3.8	3.1	.6	1.3	.6	100
Montezuma Lumber Company 34/32	0	0	0	.9	1.7	3.4	12.6	25.2	32.8 2/	12.6	10.8	100

1/ Average size in Inland Empire for mills operating kilns.
2/ Average size at Montezuma Lumber Company.

The above figures for the Montezuma Lumber Company are based upon measurements of 150 boards and represent average practice. Percentage figures in each column indicate number of boards in each thickness class. The Montezuma Lumber Company produced only 1.7 boards out of 100 that were 32/32nds of an inch thick contrasted to 27.5 out of 100 in the Inland Empire. The table indicates that they are sawing 4/4 lumber 4/32nds of an inch thicker than the normal Inland Empire practice. Usually when an operation fails to yield an overrun, scaling practices are questioned. The foregoing indicates it is sometimes well to look elsewhere for at least a part of the loss in overrun.

PACIFIC NORTHWEST FOREST EXPERIMENT STATION

Section of Forest Products

A carload (11-1/2 cords) of selected western hemlock and Sitka spruce wood was collected and shipped to the Forest Products Laboratory. Most of it came from the Wind River Experimental Forest, and its collection and loading was supervised by Mr. Isaac. The material was selected to show rapid and slow growth in both old- and second-growth trees, and will be used to determine the effect of wood density on the yield and quality of pulp.

Statistics. The annual summary of water-borne cascara bark shipments from Oregon and Washington based on the reports of port wardens and the Portland Merchants Exchange was compiled. Oregon shipped 353 tons and Washington 530 tons in 1935.

The annual log, round timber, and burl export summaries were compiled for Washington; the Oregon summary cannot be completed because the Coos Bay data are not yet available. Burl exports, the only items complete for both States, indicate that Pacific Northwest figured woods are in demand in Europe. Maple, madrone, myrtle, and redwood burls are in greatest demand.

The annual statements of log and shingle prices have been prepared and are ready for distribution.

Mill Production Studies. Tests of various combinations of annual average selling prices indicate that the 1925- 1934 ten-year average most closely approximates present sales realizations. Therefore these data will be used in this and further studies to be made within the next year or two.

Miscellaneous Studies. Pole Preservation. In preparation for inspecting the installations of Anaconda paste treated telephone poles not visited last year, the locations and dates of installations of all lines on east-side Oregon and west-side Washington forests have been checked through correspondence with the supervisors. Tentative plans have been made for designating 1000 poles in ten lines on as many forests for intensive periodic examination. It is hoped that the remainder of the treated poles can be considered as administrative experiments so that data as to their life span will be accumulated.

Kiln-drying in Douglas Fir Region. On February 15, Carl A. Kupfer was employed to conduct a survey of kiln-drying conditions in the Douglas fir region.

Forest Survey

Lithographed Type Maps Distributed. Lithographed type map of northwestern Oregon were received from the U. S. Geological Survey late in February. Distribution of free copies to selected public and quasi-public agencies was begun and arrangements were made for public distribution by sale at $1.10 per copy. At the same time proof copy of the southwestern quarter of Oregon was received. This was checked and corrected and returned to the Geological Survey for the final printing. The type boundary map of southeastern Oregon was completed and sent to Washington during February.

Klamath County Report Published. The forest inventory report and statistics for Klamath County, Oreg., the first of the east side counties to be completed, has been printed and distributed. The explanatory text to accompany county statistics has been prepared and printed. Reports for Wasco and Jefferson Counties are now being prepared and it is expected these can be issued at about two-week intervals hereafter.

Status of Inventory Compilation. Type and volume data for Wasco, Jefferson, and Lake Counties, Oreg., and Yakima County, Wash., are complete. Substantial progress is being made on other counties.

Section of Silviculture

Fire Studies. Matthews attended the Spokane meeting and delivered papers on the Station's visibility studies (including a report on the current use of the haze meters by the Forests in Region 6) and reported upon the Forest Insurance study. A set of the inexpensive instruments for measuring various elements of fire weather was displayed at the meeting. The use of fire danger measurements in Region 6 was explained to the group. The lookout goggles developed at the Station were adopted as standard equipment for Service-wide use and they are to be stocked by the supply depot. The preliminary work being done here in studying fuels by means of numerous small plots to determine rate of spread and difficulty of control was explained at the meeting and aroused considerable interest.

The meeting provided an excellent opportunity to exchange ideas and compare results. It was very apparent that national forest fire control policies and practices have set up goals that can be attained only when fundamental information on fire behavior, weather and fuel relationships, man-power production, and other important factors is available to every executive. Therefore there was manifest at the meeting an appreciation of the contributions research has already made and a demand that research speed up its study of fire problems and contribute even more in the future.

Douglas Fir Silviculture. The report of the reproduction survey of the Tillamook Burn described last month is now available in mimeographed form and has been digested for Forest Research Notes. A part of the area now a barren waste, with eroding hillsides due to a second burn, serves as a striking example of what may be expected on the remainder of this highly productive area if it is allowed to reburn. The report aroused enough public interest to get front page publicity in local papers.

It is rather singular that of the two newly approved PWA road projects, one, the Wilson River Road, crosses the Tillamook Burn, and the other, the Wolf Creek Road, crosses a smaller companion burn (the Wolf Creek Burn). Whether these roads turn out to be a blessing or a curse to the areas remains to be seen, but they should materially aid protection and stimulate salvage.

Clear days and frosty nights in late February started sap flowing and inspired a study to test flow and suitability of the sap of bigleaf maple for maple sirup and sugar at the Wind River Experimental Forest.

In the spruce-hemlock region a mixed nondescript stand of spruce and alder sometimes develops after clear cutting or burning. Such stands are neither good spruce nor good alder. Such stands are starting on limited areas at Cascade Head, and during the month Isaac prepared a working plan for a study of release cuttings in these stands. The work will start promptly and will be done by CCC or relief labor.

Phenology. Continued and record-breaking cold weather during February checked all plant growth in the Pacific Northwest and some native shrubs that had started to grow in late January were considerably damaged by the frost. The February cold wave was not as damaging to plants as the early November freeze which killed not only some of the more tender species in the Wind River arboretum and those planted on home grounds and parks, but browned the foliage of the more exposed native Douglas fir. It is reported that the November freeze did serious damage to English walnut orchards and other broadleaf species in the milder portions of the regions.

The growth events of forest vegetation were observed and recorded by forest rangers and others during the 1935 season, as in the past eight years. These records compiled during February show that observations were made at 16 stations in the Douglas fir region and at 13 in the pine type. The number of observations recorded totaled 2,733 for all stations.

Experimental Forests. During February the office work on the intensive cruise and type maps of the Blue Mountain Experimental Forest continued to be the chief project of work for Junior Forester Rasmussen and three ERA computers. The computations are about com-

pleted but the drafting and coloring in connection with the several type maps remains to be done.

Kolbe and Beeman spent a large part of February in writing the establishment reports for the 25 permanent sample plots now located on the Pringle Falls Experimental Forest area. These plots cover a wide range of conditions and are to furnish a basis for determining the effect of grazing on pine reproduction, the increased growth brought about by intermediate cuttings of various kinds, and the influence of ground cover on the establishment and growth of ponderosa pine. These office reports or initial progress reports will be completed early in March.

Severe weather at the Wind River Experimental Forest held the building of the office at a standstill. Work was limited to miscellaneous repairs and to the establishment of sample plots for the study of the reproduction of Douglas fir Christmas trees. It has been found that if one vigorous limb is left on the stump after a Christmas tree is removed this limb will straighten up and form a new tree.

At the Cascade Head Experimental Forest in the spruce-hemlock type, road work by the 25-man CCC crew and the 25-man ERA crew has not been halted by weather to date. Junior Forester Nance is now engaged in the preparation of a 5-foot contour map of the new headquarters site.

There are no weather records available for that vicinity; therefore, beginning the first of the year, three temporary stations were set up to secure some preliminary records. Because of pronounced local weather variations these three stations were set up within the area of a township, one on the coast and two about 5 miles inland.

Mensuration

A new project, the study of growth cycles in ponderosa pine, was started this month. One ERA man is devoting all of his time to the core measuring. The purpose of the project is to determine the extent and intensity of growth cycles in ponderosa pine in Oregon and Washington. It will supplement F. P. Keen's study ("Entomology - Bark Beetle Epidemics") of the Klamath Basin area by extending the study to other areas in the ponderosa pine region of Oregon and Washington. Cores are available from five areas not included in the entomological study, namely, Lakeview, Blue Mountain, Warm Springs Agency, Bear Springs, and Dufur, in Oregon.

A series of coordinated curves of height over diameter by site and age classes for even-aged stands of Douglas fir was prepared by Dr. Meyer. They are chiefly valuable in cruising. Availability of these curves makes it possible to limit the field work of a cruise to tallying diameters, making a few increment borings for age-class

determination, and measuring the heights of a few trees in the dominant stand for site-class determination. A simplified office procedure for determining tree heights replaces much of the time-consuming work of measuring heights in the field.

Forest Economics

Land Economics. Work continued on analysis and report on the relation of forest cover to tax delinquency in western Oregon and Washington. In addition, trial forecasts were made of the amount of land that might be in farms in 1965 in the nine western Washington counties studied under the New Public Domain project. These forecasts were based upon 1880-1935 trends in the total amount of land in farms and the amount of improved land in farms.

The program and exhibits for the Land Resources Division of the Third Pacific Northwest Regional Planning Conference at Spokane were arranged and managed by Sinclair Wilson. This involved two section meetings on forestry, one each on land classification, agriculture, and wild life, and three on land planning in general. It also involved securing speakers to handle forest, agricultural, and recreational topics for other sections. Wilson estimates that at least a solid month of time was required to carry out the administrative part of this program.

Cooperation continued with the state planning boards. Wilson assisted the Oregon board in its proposed forest taxation, land ownership, and farm land inventory studies. He assisted the Washington board in its preliminary study of separating the forest from agricultural and other lands in Lewis and Snohomish Counties, the Forest Survey staff furnishing the bulk of the forest data.

Logging Economics. The growth phase of the Hines study and its correlation with the economics of selective timber management was in the forefront last month. Willison, of the Section of Forest Measurements, completed an analysis of gross growth by d.b.h. and by Keen's tree classes, based upon approximately 1,200 sample tree borings taken last summer on the Burns working circle. Net growth was then computed on the basis of Keen's mortality ratios, after these had been translated to actual loss rates. A factor of 0.3 was used in converting ratios to annual mortality rates in percent.

The results of this analysis show that trees over 22 inches in diameter in Keen's tree Class 4-C (overmature intermediates) and those over 30 inches in Class 4-B (overmature codominants) are the particular elements of the stand which are losing in volume, i.e., normal mortality exceeds normal growth, and increasingly so with increasing d.b.h. These are also the particular tree classes which show the highest conversion values, thus making it doubly desirable that they be removed from the stand as quickly as possible.

All other tree classes, except probably Class 4-D (overmature suppressed trees) which was not analyzed owing to insufficient data, contribute to the normal net growth per acre, in spite of seemingly high mortality ratios and unsatisfactory growth rates. The significance of this is that the highest net growth per acre, during the first cutting cycle, would be attained by avoiding, insofar as practicable, all cutting of trees of age classes 1, 2, and 3 (trees generally less than 300 years old). To the extent that this type of selection also makes it economically feasible to go through quickly with a very light cut, it will naturally contribute still further to growth by putting more acres into productive condition within a given length of time.

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

General

L. J. Palmer returned to the Station February 9, after a three months' detail to the Washington office. Dr. David F. Costello reported for duty as Assistant in Range Research on February 28. McArdle left for the west coast on February 11th to attend the Spokane fire conference and to complete three manuscripts for the Northwest station. He will also contact Connaughton and Johnson at the San Dimas branch of the California station where they are studying methods used in Forest Influence investigations before beginning somewhat similar studies for this station.

One of the major jobs of the station at present is to let the people of the region know of the station's existence. To this end, speaking engagements have been sought. Arrangements have been made to talk over one of the Denver radio stations once or twice each month during the weekly State College radio hour. On February 16th Taylor made a radio talk describing the work to be undertaken by the Rocky Mountain station. McArdle addressed the Colorado State College Faculty Club at its monthly dinner, outlining proposed station work and cooperation with the College. He also made the principal address at the annual meeting of the Colorado Forestry Association in Denver. Palmer addressed the Fort Collins Lions Club on the subject of range research in Alaska.

An audit of the station's accounts was made during February by Mr. Wilt of the Washington office and Mr. Stanley of the Denver office. The books were pronounced in good shape and the new organization is glad to find itself on a firm accounting basis.

Division of Silvics

The research committee for forest management studies met February 4th and 5th to outline a recommended program for submission to the Regional Research Council which will meet late in March. The results of the meeting were very satisfactory to all concerned. Similar committees will prepare recommendations for range investigations and for forest influences studies. A member of each committee will sit with the Research Council and submit the recommendations of his committee for final action to be taken by the Council.

During the month Roeser completed the first draft of a climatological report for the Fremont Experimental Forest. The data were taken primarily for a study of the influence of forest cover on climatic factors.

Growth data from permanent sample plots scattered over Region 2 are being analyzed and summarized for use in proposed growth and yield studies. All analyses and summaries of old work are expected to be completed by July first.

Preliminary work plans for growth and yield studies in the Black Hills ponderosa pine type and in the lodgepole pine type are being prepared. Similar plans for obtaining volume table data while making the yield studies, and instructions for obtaining correct volume measurements on the national forests by the administrative field force also are in process of preparation.

Division of Range Research

Palmer and Costello having just arrived, work has been limited to a preliminary analysis of past research carried on by the Regional Office. These studies are being summarized and tentative plans for the 1936 season are in preparation.

Division of Forest Influences.

C. A. Connaughton has accepted a transfer from the Intermountain Station to take charge of this division and Wallace Johnson from the same Station will assist him. Both men will return to Fort Collins from the San Dimas Branch of the California Station in March to prepare plans for the season's research.

SOUTHERN FOREST EXPERIMENT STATION

Forest Management

During the month field work in connection with the Station's first experiment in pruning longleaf pine, was completed at McNeill with the help of CCC and WPA labor. This experiment deals with second growth longleaf pines from 2 to 8 inches d.b.h. and mainly 15 to 30 years of age. Left unpruned, these trees usually remain so studded with live limbs or stubs throughout the lower 17 to 25 feet that they produce very little clear material when grown to a merchantable size. The specific objects of the experiment are: (1) to determine the labor costs of pruning in relation to tool, method, height pruned, number and size of limbs, and size of tree; (2) to determine the relationships between the size and limbiness of a tree and the probable profit or loss through pruning; (3) to determine the effects of various heights of pruning on diameter and on height growth; and (4) to determine the effects on the technical quality and commercial value of the wood of pruning with different tools and to various degrees of closeness or with varying skill and care.

The McNeill study is based on observations of 1,303 tagged trees of which 108 trees were left unpruned as checks, 221 trees were pruned to a point 8 feet above ground, 100 trees to 12 feet, 668 trees to 17 feet, and 206 trees to 25 feet. The various pruning treatments were distributed equally through three 2-inch d.b.h. classes and over the entire area of 150 acres on which the tagged trees occur. Tools used included an ordinary axe, a belt axe, 4 types of handsaws, and 2 different pole saws, one of the latter being used with an 8-, a 12-, and a 20-foot handle. The handsaws were used from the ground and from 8-, 12-, and 20-foot ladders. Six men did the pruning and the performance of each man was timed with a stop watch. Detailed data were taken on the number and size of limbs cut from each pruned section and on the size and crown characteristics of each tree.

Forest Survey

General

"Pulping and non-pulping cordwood volume in the longleaf pine region of Mississippi and eastern Louisiana" was released during February. The Industrial Committee of the Association of Commerce of New Orleans were given a talk on the Survey and some of its findings by Captain Eldredge.

Field Inventory

The eight survey crews in Florida Unit #3 made splendid progress during the month. Two crews under White and O'Kelly were assigned lines passing through the Big Cypress Swamp. Due to the inaccessible area, it was necessary to employ a guide and an ox cart, which enabled the crews to camp on line where night caught them. The crews in Georgia will finish the work in the state by March 10, and then transfer to Alabama with headquarters at Decatur.

Volume table field work has been completed for the South. Over 40,000 trees were measured, requiring six months field work and 30,000 miles travel by automobile. From these data 130 to 140 tables will be compiled, but it is expected that tables showing a marked similarity in contiguous units will be combined.

The sampling was done by taking plots at 10-mile intervals along the roads in a prearranged highway network that covered each unit uniformly. Not more than 20 trees were taken randomly on each plot.

The ocular "form class" system, developed by J. W. Girard, was used to obtain the field data.

The accuracy of this ocular system of gathering volume table data is shown by the following figures, taken by F. Lemieux:

No. trees climbed	Volume Ocular	Measured Tree Volume (Scribner Rule)
4,135	441,451 Bd. ft.	441,562 Bd. ft.

A minus error of .023%

The error by individual survey unit ranged from .46% to .006%.

Density of Second-growth Stands in the Longleaf Type

Each quarter-acre plot in the second-growth stands of the longleaf type has been classified according to the stand-density index method, developed by Reinecke. 1/ One hundred trees to the plot having an average diameter of 8 inches is the base used. This was chosen after examination of the densest plots.

	Density Classes			
	Less than 1	1-10	11-50	51-100
Percent of plots	18.3	43.8	35.1	2.8

1/ L. N. Reinecke - Perfecting a stand-density index for even-aged forests, Journal of Agricultural Research, Vol. 46, No. 7, April 1, 1933. pp. 627-638.

Naval Stores Practice

For several years a campaign has been underway in Florida to get Naval Stores operators to maintain a 9-inch diameter limit in hanging cups. Apparently, this campaign has borne fruit, for, as indicated below, only 30 percent of the 8-inch class trees are worked in virgin crops.

D. B. H.	Front-Cupped Working Trees	Round Trees	Total	Proportion Working Trees to total (Percent)
8	815	1924	2739	30
10	945	189	1134	83
12	664	22	686	97
14 & up	415	0	415	100

CURRENT ANNUAL MORTALITY FIGURES

Species Groups	Forest Conditions					
	Old Growth		Second Growth			
			Sawlog Size		Under Sawlog Size	
	Cu.ft.[1]	Bd.ft.[2]	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.
	Percents					
Round Turpentine Pines	5.9	5.4	2.2	2.3	2.0	4.9
Turpentined Pines	9.0	8.7	4.6	4.3	8.2	10.6
Non-Turpentined Pines	3.0	2.8	2.8	2.8	4.7	6.2
Hardwoods	2.4		2.4		3.1	

1/ Cubic foot volume outside bark
2/ International 1/4" Rule.

The table immediately following shows the net changes taking place in round turpentine pines in the turpentine pine types uncut during 1934.

CURRENT ANNUAL GROWTH AND MORTALITY FIGURES (1934)

(Turpentine Pine Types - Round Turpentine Pines)

Forest Conditions	Growth		Mortality		Net Change 3/	
	Cu.ft. 1/	Bd.ft. 2/	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.
	Percents					
Old-growth Uncut	2.6	3.0	5.9	5.4	-3.4	-2.5
Partly Cut	4.6	5.0	5.9	5.4	-1.4	-0.1
Second-growth Sawlog size	6.6	10.4	2.2	2.3	+4.3	+8.0
Under Sawlog Size	11.4	24.3	2.0	4.9	+9.3	+18.8

1/ Cubic foot volume outside bark.

2/ International 1/4" Rule.

3/ Growth calculated on live trees living through the year and on one-half trees dying when no cutting takes place.

Winters gave a talk on "Collards and Cordwood-The Farms of Tomorrow" at the 37th annual convention of the Association of Southern Agricultural Workers at Jackson, Mississippi.

Forest Pathology

An inspection of areas located on the Choctawhatchee, Apalachicola, and Osceola Units in Florida and the Wambaw Unit in South Carolina to obtain information on the occurrence of the brown-spot needle blight of longleaf pine in relation to fire occurrence revealed that, in general, there was less needle infection on recently burned areas than on the older "roughs". Enough examinations were made to permit comparison of the present type of infection on the Choctawhatchee, Apalachicola, and Wambaw Units. The worst infections were found on the Choctawhatchee Unit. The needle blight was much less abundant on the Apalachicola Unit and least on the Wambaw Unit.

Forest Products

During the first week of February, a cooperative sap-stain and Lyctus beetle-control test was established at Vicksburg, Miss., by the Bureau of Plant Industry and the Bureau of Entomology and Plant Quarantine. Forty-six chemicals and chemical combinations were applied to either oak, ash, or hickory boards as dipping treatments. Half of the treated boards were then placed in a screened cage containing infested material, and the other half were placed in the drying yard along with infested material. Observations will be made every 3 months, and new tests established at these 3-month intervals.

Exposures of Petri dishes and pine blocks were made at two mills in order to get further information on sap-stain dissemination.

Forest Entomology

Snyder delivered an address on Lyctus beetles before representatives of the National Lumber Exporters' Association at the 36th Annual meeting of this group, held in New Orleans February 17-20. During the month he also examined barkbeetle attacks on pine at Crossett, Arkansas and control work against leaf-cutting ants in plantations on the Kisatchie National Forest.

SOUTHWESTERN FOREST & RANGE EXPERIMENT STATION

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With deep regret announcement is made of the death on March 4 of Mrs. C. K. Cooperrider. Courageous in her long illness, a noble woman and mother, and loved by all who knew her, friends throughout the Forest Service will mourn her passing and extend to their associate, her husband, and to her children deepest sympathy in their loss.

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FOREST MANAGEMENT - PONDEROSA PINE

Yield Tables

Lexen has completed a new yield table for many-aged cutover stands of ponderosa pine, based on 20-year records of growth and mortality on three sample plots whose aggregate area is 394 acres. Since the plots were cut by three different methods, they present a wide range as to volume and character of residual stand. The plots were divided into 394 one-acre sub-plots which were treated statistically with reference to increment in relation to volume and average d.b.h. of the stands as they existed when the plots were established in 1913. Increment is expressed in both cubic and board measure. The accompanying tables, which are for board measure only, give the gross annual increment per acre and the increment percent.

Mean Annual Growth after Cutting
Coconino National Forest

Avg. d.b.h.	Reserved volume in bd. ft. per acre							
	1000	2000	3000	4000	5000	6000	7000	8000
	Gross Mean Annual Growth in Bd. Ft.[1/] per acre							
12	75							
14	59	94	126					
16	46	76	102	125	147	167	186	
18	38	62	83	102	120	136	152	
20	32	52	70	86	100	114	128	140
22	28	45	60	74	86	98	109	120
24	24	38	52	63	74	85	94	104
26	21	34	45	56	65	74	83	91
28	19	30	40	50	58	66	74	
30	16	27	36	44	52	59	66	
32		24	32	40				

1/ Average annual mortality approximately 20 bd. ft.

Annual Growth Percent
Coconino National Forest

Avg. d.b.h.	Reserved volume in bd. ft. per acre							
	1000	2000	3000	4000	5000	6000	7000	8000
	%	%	%	%	%	%	%	%
12	7.50							
14	5.90	4.75	4.20					
16	4.65	3.81	3.40	3.13	2.93	2.78	2.66	
18	3.85	3.12	2.77	2.56	2.39	2.27	2.17	
20	3.22	2.61	2.32	2.14	2.01	1.91	1.82	1.76
22	2.80	2.25	2.00	1.84	1.72	1.63	1.56	1.50
24	2.37	1.92	1.72	1.58	1.48	1.41	1.35	1.30
26	2.10	1.70	1.51	1.39	1.30	1.24	1.18	1.14
28	1.87	1.51	1.35	1.24	1.16	1.11	1.06	
30	1.65	1.34	1.19	1.10	1.03	.98		
32		1.20	1.07	.99				

After many tests by trial and error it has been found that growth after cutting can be closely approximated by the formula:

$$G = \frac{R^{k_1}}{D^{k_2}} \times C$$

Where G = growth after cutting. (In this case the total growth for 20 years).

R = Reserved volume.
D = Average d.b.h. of stand
k_1, k_2, and C are constants determined by the method of least squares.

In other words, the formula implies that the logarithm of growth is directly proportional to the logarithm of reserved volume and inversely proportional to the logarithm of average diameter.

Tests made against observed data, however, pointed out that beyond certain lower limits the formula did not strictly hold. Thus, for cubic feet, growth values for stands of average diameter below 8.0 inches were distinctly out of line, and for board feet, growth values for small reserved volumes (250 board feet or less) were also out of line. The exact cause of this lack of uniformity was not definitely determined, although the relatively greater influence of merchantability limits on stands of small reserves and low average stand diameters was thought to be the disturbing factor. Fortunately, these limitations are of no practical importance inasmuch as interest always centers about stands having larger average diameters and reserved volumes.

During the course of analysis it was also demonstrated that the influence of average stand diameters lies not so much in the fact that trees of small diameters grow more rapidly than trees of large diameters or vice versa, as in the fact that for a given reserved volume the actual amount of growing surface increases steadily with a decrease in average diameter.

Mill Scale Study

The field work on the mill scale study has been completed and the data are being analyzed in the Regional office.

GRAZING ECONOMIC SURVEY

H. O. Cassidy of the Station staff, who was assigned to the Regional Office in October 1935 to assist the Division of Range Management in its Economic Survey, continued in that capacity through February. Another month will be required to work up field data already collected.

RANGE RESEARCH

JORNADA EXPERIMENTAL RANGE

Forage Crop

Good forage is expected this spring due to growth of annuals as a result of winter rains. January was above normal in precipitation, but there was only .14 inch in February.

Range Management

Studies for determination of grazing capacity by actual use were continued by placing 30 cattle in black grama enclosure in pasture 2, February 8. Close attention was given proper distribution elsewhere on the range.

Revegetation

Current Work: Plot B, of 10 acres, was transplanted with chamiso seedlings at 6-ft. intervals. Seedlings were dug from mesquite dunes mostly within the 10 acres transplanted. Stems averaged about 5 inches in height and roots were about 12 inches long. (This represents about one-third of the length of the taproots). Holes were forced into the wet sand to a depth of about 15 inches with "dibble" sticks made by sharpening broken shovel handles. Plants were placed in the hole and soil forced against the roots with the "dibble" stick. 9,000 chamiso seedlings were planted at an average

cost of $7.20 an acre or 8 cents per plant. Examination of the area on February 26 showed the plants still alive.

Past Results: From the limited artificial revegetation experiments begun in 1934 in the mesquite sand dune area and continued through 1935, the following tentative conclusions are drawn:

1. Clumps of grass can be successfully transplanted by the paper sack method for about 4 cents per plant, which is probably cheaper than transplanting nursery grown seedlings that may have to be transported for long distances.

2. No germination resulted from the seeds planted in 1934. About 10 percent of Paspalum seeds planted in 1935 germinated, but these died because they were planted too late to get benefit from the best rains. During 1935 many seedlings of dropseed grasses grew naturally on the better grasslands and numerous chamiso seedlings were found in protected places in the mesquite lands. To afford good places for the seeds to lodge, it is suggested that artificial hedges be constructed across the blow-outs by partially burying dead brush and yucca stumps found in the area. These hedges will decrease the wind erosion and will furnish good places for the seeds to germinate.

3. Study of rodent damage showed that cropping of seed stalks and blades of grasses was heavy during a droughty year such as 1934, but not so conspicuous in years of average rainfall and plant growth such as 1935. Rodents are numerous on the mesquite lands, and some control of their population by use of poisoned grain is advisable for a few years if transplanting or reseeding is done.

4. Paspalum grass appears to be well suited to the mesquite lands because it produces large seeds that germinate readily, plants are able to spread by tillering, and they thrive in sandy soil. A limited quantity of seed was collected in 1935 and is available for experimental planting.

5. Grass seeds planted 4 inches deep may have germinated but were unable to reach the soil surface as seedlings; those planted 1 inch deep produced as many seedlings as those germinated in the laboratory.

6. Dropseed grasses produce numerous seed that are nearly impervious to water and give low germination percentages, but mechanical scarification of those seed will increase the germination from about 3 percent to about 43 percent. Alkali sacaton, a dropseed grass, gave a good germination percentage without scarification.

7. Revegetation in the mesquite lands requires at least average water conditions and should be accomplished during the rainy seasons of years that are likely to give average rainfall or better.

8. Black grama does not produce many seeds under natural conditions in southern New Mexico, but the seeds do give a high germination percentage. This grass, and other plants that produce few seeds naturally, should be grown on irrigated lands to see if they will produce more seeds.

9. Chamiso is well adapted to the mesquite lands, and it produces many viable seeds so that special consideration should be given this shrub in plans for revegetation of these lands. It is advisable to transplant the 1935 crop of chamiso seedlings from the dunes to the blow-outs.

10. If plants are to be successful in the mesquite lands, they must be able to resist drought, reproduce vegetatively, produce seeds in years of low-rainfall, and to withstand some wind erosion and deposition of sand.

Poison Plant Eradication

Poison plant eradication has been carried on at the south end of the Jornada during the past few months. The Astragalus crassicarpus, A. allochrous, and A. bigelovii are very thick in spots, both large plants and current seedlings just growing. The progress is very erratic because of the irregularity of the plants. At times the CCC crew has covered 400 acres a day, other times only 100 acres. Total area to date of 3,000 acres has been covered at a cost of $.135 per acre, exclusive of supervising costs. Plants were dug out with hoes with 3 or more inches of root and kicked clear of the dirt to prevent any sprouting. These plants are very widespread over the entire range. For complete eradication, the area should be worked over every three to four months in rotation for two growing seasons. The cost to date undoubtedly can be reduced in future work.

Improvements

Cooperative agreement has been entered into with the New Mexico State College for construction and drilling of a well on the west boundary of the Jornada, which is to be used to supply water to the ranges of both the Jornada and State College Ranch. The proposed well, reservoir, and troughs will be wholly within the Jornada boundary. The State College is furnishing all labor and machinery to drill the well, and labor and materials to lay two pipe lines from the reservoir to their water troughs. No Forest Service CCC labor will be involved in well drilling or laying pipe off of the Jornada.

Drilling of the well was begun January 20, 1936 and finished February 12 at a depth of 356 feet. The tower and mill have already been erected, and work will begin shortly on laying the pipe line to troughs.

Other CCC projects consisting of truck and horse trails, fencing and spring development all progressed rapidly.

Public Relations

Outside visitors and purpose of visit were:

1. C. F. Martineau, Resettlement Administration - revegetation work.

2. Joe Christy and Mr. Dodson, Regional Soilsmen, Soil Conservation Service - revegetation and rain hole projects.

3. Entire class of 12 students with Professor Neale of New Mexico State College range management class - all phases of range research.

SANTA RITA EXPERIMENTAL RANGE

In 1921 R. R. Hill started a clipping experiment to determine the effect of clipping at different intervals and heights upon the amount of vegetation produced, longevity of the plants and amount of reproduction of the more common range grasses. This study was continued throughout 1922 and the results indicated that seasonal variation in rainfall affected the grasses more than close and frequent clipping. Rainfall was rather favorable and this probably obstructed the effects that clipping might otherwise have had.

In 1925 a similar study was started with two specific objectives in mind:

1. To determine the danger point in the degree of forage utilization beyond which continued grazing over a period of years would result in range deterioration.

2. To determine the extent to which such factors as rainfall and actual average yield of forage, ordinarily not adequately considered, should be taken into account when estimating sustained grazing capacity of the semidesert grassland ranges.

This study was continued through 1933 covering a period of 9 years during which a fair average of drought and good years was encountered. The work was pursued on two somewhat different types of grass land. The upper range, which supported a rather good stand of such grasses as spruce-top grama (Bouteloua chondrosioides), slender grama (B. filiformis), curly-mesquite (Hilaria belangeri), and hairy grama (B. hirsuta); and on the middle range, which supported chiefly Rothrock grama (B. rothrockii) and black grama (B. eriopoda).

Quadrats were clipped at 1 and 2 inches above the ground at weekly, bi-weekly, monthly and close-of-season intervals. Effects

of the various clipping methods were secured through measurements of density, height growth and yield of forage, the latter being expressed on an air dried basis.

Brief summarization of the results shows:

1. In almost every instance relative density, height growth and yield averaged definitely higher under 2 inch clipping than under 1 inch clipping. As the clipping intensity increased, the two figures tended to come somewhat closer together.

2. During the first seven years of the study rainfall conditions showed a definite upward trend. Under this condition the grasses clipped at 2 inches showed a more pronounced tendency toward increased density, height growth and production than did those clipped at 1 inch.

3. Following this seven year period were two years of greatly diminished rainfall during which the 2-inch clipped grasses showed definitely greater resistence than those clipped to 1 inch in the matter of both density and forage yields. This is perhaps the most important result of the study inasmuch as it shows rather definitely that conservative use will do much to overcome the adverse effects of drought conditions.

4. Throughout the study it was apparent that certain of the grasses, notably curly-mesquite, were able to withstand close clipping better than the others and still produce good yields of forage.

5. On the upper range correlation between differences in density and yield on the one hand and variation in yearlong rainfall on the other hand were rather close, while on the middle range this correlation applied only to density. The fact that there was no significant association between yield of forage and rainfall on the middle range was due to the extremely erratic growth behavior of Rothrock grama.

6. In connection with the rainfall influence is one other observation, namely that dry periods of not more than one week's duration during the summer growing season frequently resulted in almost complete temporary cessation of growth, thus indicating that even during this period (which is the main growing season of the year) rather continuous rainfall is essential to the greatest production of forage. As regards surface soil erosion, frequent close clipping was shown to greatly increase it.

Practical Conclusions

In the final application of the results to the determination of range capacity the following points seem to stand out:

1. That the different grasses varied greatly in their ability to produce forage and that this fact should be definitely taken into account.

2. That the average yield of forage over a period of years was not a satisfactory basis for determining range capacity.

3. That a safety factor of at least 15% should be allowed in order to establish conservative range capacity.

4. That on the upper range, use of forage to within approximately 2 inches of the ground appeared satisfactory while on the middle range a slightly more conservative degree of use seems desirable.

In order to test out the results in a practical way the yields of forage as determined by the clipping study were applied to two range areas (one in the upper range and one in the middle range) on which the numbers of stock that could be run were known. The results of the clipping study gave range capacity figures which agreed very closely with the known figures, being slightly more conservative in both cases.

FOREST INFLUENCES

Parker Creek Experimental Forest

Slow-falling winter rains, continuing over several days, are sufficient in supplying water to streams and reservoirs in central Arizona. During the period February 11 to 19, 1936, 5.10 inches of rainfall fell. Water storage in the four Salt River reservoirs rose from 469,560 acre-feet to 616,400 acre-feet.

The effect of herbaceous cover on surface run-off and percolation from winter storms is shown by results from the battery of 10 small steel lysimeters at Parker Creek. This set of lysimeters, 50 square inches in area, 22 inches in depth, and with a slope of 25 percent yielded most of this storm's water was percolation but there was significant relation between density of cover and amount of water yielded to lower levels.

The combined average total of rain water contributed as surface run-off and percolation by these 10 lysimeters, which represent 5 conditions of plant cover, ranging from bare to 33 percent density of grass, was 4.31 inches of rain, or 92 percent of the rainfall. The blanks had the highest amount of surface run-off, 2.42 inches of rain, or 47 percent of precipitation, and the least amount of percolation, 2.28 inches or 45 percent. On the other hand, the two lysimeters of most dense grass cover had the least amount of run-off, .10 inch, or 2 percent, and the greatest amount of percolation, 4.30 inches, or 84.3 percent.

Amount of silt eroded from these lysimeter surfaces by slow winter rains such as these is very slight, that is, from an average of four-fifths of a cubic inch from bare surfaces to only one-fifth from the surfaces with the 33 percent density of grass.

Run-off from large areas of bare and sparsely vegetated ground surfaces temporarily add to the normal high flows from winter storms. A dense cover of grass reduces surface run-off greatly and increases percolation to produce more regulated, lasting flow of streams. Abnormally high run-off results in increased erosion of flood plains and hastens the silting of reservoirs.

The fact that bare lysimeters gave slightly higher total quantities of water from the rain is apparently due to storage of a small amount of water in the summer growing season when plants in the other lysimeters are using the soil moisture. As a result, the bare lysimeters become saturated first and are among the first to contribute percolation water from winter storms. However, any apparent superiority of bare soil in yielding water is more than offset by the greatly accelerated erosion from bare lysimeters in summer storms. A grass cover is essential to prevent destructive effects of accelerated run-off to soil and plant cover during the growing season when stream flow is insignificant because of high evaporation.

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